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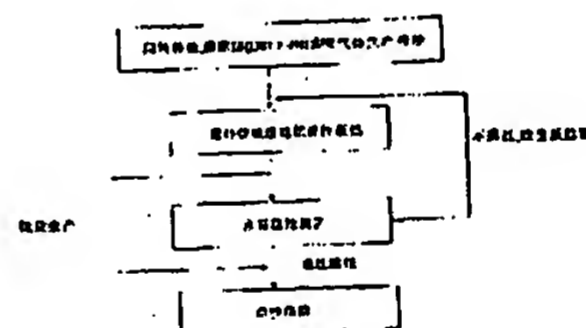
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权利要求书 1 页 说明书 5 页 附图页数 6 页

[54]发明名称 无扭力单纱

[57]摘要

无扭力短纤维纱在一个第一步骤中在一个方向加捻,然后在另一个步骤中 在一个相反的方向加捻。对所需方法的参数进行设置以便生产出一种短纤维单 纱,在该短纤维单纱中,中央纱芯中的剩余扭力基本上由围绕
着纱芯的纤维中 的剩余扭力进行平衡。



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1. 一种生产无扭力短纤维单纱的方法, 它包括一个生产短纤维纱的第一步骤, 该短纤维纱在其横截面上具有不均匀的径向捻度分布, 和一个施加机械力对纱线进行反旋向退捻的第二步骤, 该步骤是以这样的受控方式进行的, 即在纱线的中央纱芯中的所有剩余扭力基本上由围绕着纱芯的纤维中的剩余扭力进行平衡。
5
2. 根据权利要求 1 的方法, 其中所说方法是一种在两个独立的步骤中进行的分批法。
- 10 3. 根据权利要求 1 的方法, 其中所说方法是在一个具有两个顺序排列步骤的连续处理过程中进行的, 纱线要通过顺序排列的纱线生产和加捻设备。
4. 根据权利要求 1 的方法, 其中所说第二步骤是由一台环锭捻线机完成的。
- 15 5. 根据权利要求 1 的方法, 其中所说第二步骤是由一台倍捻捻线机完成的。

无扭力单纱

5 本发明涉及无扭力单纱。

对短纤维纱进行加捻是已知的。对短纤维纱进行加捻主要是要使其具有结构完整性并在用这种纱线制造织物时获得所需的特性。加捻已经实地应用了几十年，但常常导致生产的单纱明显留有剩余扭力。解决的办法是使用两股缠绕在一起的单纱来制造织物，将这两股单纱的剩余扭力安置在相反的方向上。

10 作为更为一般的解释或背景，加捻纱的剩余扭力或捻度不稳定性在其他因素中成为对这种纱线制造的单面针织物的转曲度产生影响的最突出和重要的因素。如果将捻度不稳定纱用于针织品，所形成的线圈将不能对称，因为在纱线中存在不定的扭转应变。该加捻纱将具有一种退捻和退解加捻纱内部扭转应变的趋势，以求得一种最小能量状态的自然构形。该纱线在织物中将试图旋转；
15 这样，线圈的一侧将从表面鼓出来而线圈的另一侧则停留在织物内。这种线圈对称性的扭变引起了转曲，即，线圈和织物上的罗纹花纹的倾斜。

在一种针织物上的转曲度随所用纤维类型的不同而变化。这就是说，不同类型的纤维具有不同的模量（抗拉、弯曲和切变）和不同的横截面形状；因此，就会在纱线中出现不同的应力水平。纱线中扭力的增加提高了纱线中的捻度不
20 稳定度并且因此增进了这种纱线制造的单面针织物的转曲。因此，不同纤维在抗拉模量上的不同将影响到在随后的纱线和针织材料处理过程中由于纱线伸张而产生的纱线扭力的大小。可以说，在棉/聚酯混纺纱中增加聚酯的百分比将在环锭纱和气流纱两种纱线中增加捻度不稳定性并因此在这种纱制造的单面针织物中增加了转曲扭变。由于在相同码长的棉/聚酯混纺纱中聚酯含量较高而在单
25 面针织物中出现转曲增加的原因，很可能是因为模量较高和两种纤维类型之间的横截面形状有差异。

在纺织纱线中加捻产生一种通过摩擦将纤维结合在一起的横向力。可是事实上，在不同的纱线结构中，内应力的分布是不同的。实验结果表明摩擦纱（DREF-II）具有最高的纱线剩余扭力或缠结趋势，而通过环锭纺、气流纺（转
30 杯纺）和喷气纺生产的纱线则具有较小的剩余扭力。此外，由摩擦纱制成的织

物上的转曲角在其织物之中是最大的。

这四种纱线的剩余扭力的不同反映出其结构的差异。环锭单纱通常被认为是由在纱线横截面内具有均匀堆砌密度的同心螺旋构成的，而纤维转移则是一个次要特征。这样，当纱线退捻到初始捻度水平时，其强度减至零因而纱线将崩溃。相反，非常规纺纱系统生产出了具有不均匀捻度分布的纱线，其中包括气流纱、喷气纱和摩擦纱。此外，在这些纱线中的堆砌密度不是均匀的，局部纤维缠结和包缠是其共同特征。这些纱线的强度在退捻时没有变成零。

因此，有几种因素在严重影响纱线的剩余扭力，其中有纤维类型、纤维的横截面形状、纺纱系统和纱线的几何结构。另外还有许多因素影响纱线中的剩余扭转应力水平和/或影响在针织组织内部的线圈运动的相对自由度，以致影响在最终织物中的转曲。这些因素包括针织组织、针织机的设置、由于后处理产生的织物回缩和织物定形。

过去，开发了各种各样的技术来减小或消除纺织纱线中的剩余扭力。根据一条基本原理，这些技术可以被分成两个主要种类，第一是将纱线永久定形，而第二则是以物理形式平衡剩余扭力。

众所周知，引入到一种纤维中的永久定形量越多，则由纱线剩余扭力而形成的转曲度就越小。根据纤维类型可以用不同的方法进行纱线定形。在热塑纤维情况下，在纱线或织物处于受力状态下进行热处理，其温度在玻璃转变点以上但在熔点以下（如在假捻操作中）。棉/聚酯混纺单纱的热定形大大地减小了剩余扭力，甚至于在用喷气纺和气流纺形成的混纺纱中几乎可以消除织物的转曲。

对于诸如棉或毛之类的天然纤维来说，定形处理是比较复杂的，例如，汽蒸定形、在热水中定形和化学处理，例如棉纱情况下的丝光处理及毛纱情况下用亚硫酸氢钠进行的处理。可是，天然纤维的定形处理不能完全消除单纱的剩余扭力，还可能出现纤维的损坏和纱线性能的劣化。

在工业上采用的某些扭力平衡技术有：（1）将两股具有与所说单纱中的捻数相同但方向相反的同等单纱合股；（2）将两股具有相同捻度但方向相反的单纱喂入到同一个导纱器；或更简单地，（3）通过添纱法使用两股具有相同捻度但方向相反的纱进行针织。

还有人建议了一些用直接纺纱法生产无扭力单纱的方法。已提出一种用来

生产扭力平衡纱的双联式纺纱系统。用这套系统生产的纱线包括一个通过喷气系统制造的纱芯，而后用旋覆纤维以与 DREF-III 纱相同的方式将其包缠起来。最终纱线的纱芯和纱皮组分都具有相反的捻度/扭力方向。还提出一种生产环锭纺棉皮/聚酯芯纱线的技术，在此是通过使用与包覆纱捻向相反的芯纱或是通过简单地加热定形纱线的聚酯组分进行扭力平衡的。

比起定形处理，平衡方法具有明显的优点，特别是对天然纤维而言。第一，平衡纱是一种不含化学物质的物理处理，因此避免了纤维的损坏。第二，平衡方法可应用于包括天然纤维在内的所有种类的纤维。可是，当合股纱的最细支数为单纱的纺纱细度极限的一半时，如果是用两股单纱来形成平衡结构的，则目前工业上采用两股纱的通常作法对最低织物重量就有限制。如果是用直接纺纱技术来制造扭力平衡单纱的话，就会出现某些经济上的担忧，因为需要对机器进行一定的改装。

本发明的任务是克服或至少减小这些缺陷。

根据本发明，将提供一种制造无扭力短纤维纱的方法，现在将参考附图并以实施例的方式对本发明的方法进行阐述，其中：

图 1 是批量处理这种纱线的生产步骤流程图；

图 2 (a) 和 2 (b) 是分批法生产这种纱线的设备；

图 3 是不同纱线中的捻度分布图；和

图 4 (a) 和 4 (b) 是处理的纱线的原理解释图。

参考附图，在图 1 中，以两种方式实施分批法。第一种方式包括对原纱（母纱）进行处理，这些原纱来自气流纺、喷气纺和 DREF-III 三种系统中的任何一种，通过环锭或倍捻捻线机对其进行改性。所得变形纱将接受湿缠绕试验。如果经试验所得的剩余捻度在验收极限内，则该纱线满足无扭力单纱的要求，进而可以被卷绕起来。否则，就必须对改性处理进行改变直到纱线通过试验。第二种方式是用于批量生产的。通过环锭或倍捻捻线机对原纱进行改性，然后接着进行退圈并卷绕到筒子上。

参照图 2 (a)，纱线改性是由一台环锭捻线机完成的，一个供料辊 10 向一个卷取辊 11 供应纱线。另外，可以由一台图 2 (b) 所示的倍捻捻线机完成处理工作。含有原纱的筒子放在一个绕中心轴旋转的锭子 12 中，锭子每转一圈纱线得到 2 转，纱线被卷绕在卷取辊 11 上。

在图 3 中, 所显示的是四种单纱沿其纱线半径的捻度分布, 这四种纱线为: DREF-III 纱、喷气纱、气流纱和环锭纱。前三种纱线呈现出某些不均匀的捻度分布, 图 4 (a) 中说明的是 DREF-III 纱的实例。环锭纱具有均匀的分布, 因此不适用这种改性处理。

5 在图 4 (b) 中显示了根据本发明生产的无扭力纱线。纱芯 13 在第一步骤中被施加了一个捻度, 在改性过程中例如通过一台环锭或倍捻捻线机被减小。这样, 纱线的外纛或芯皮 14 就具有一个剩余捻度, 它是在第二步骤中由捻线机加捻形成的。加捻的相对量和在相反方向上的剩余扭力在纱芯 13 和外纛 14 之间基本上得以平衡。

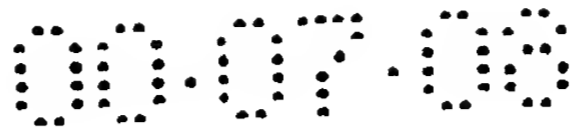
10 因此, 利用非常规纺的纱线的芯皮结构, 所述纱线的改性方法可以用于多种纺纱或加捻系统纺制的单纱, 例如, 气流纺纱、摩擦纺纱和喷气纺纱系统。这种方法可以应用于任何纤维种类及混纺。例如, 天然纤维或再生纤维, 如纯棉、纯毛、粘胶人造丝或这些纤维的混纺。例如, 可以用 100% 的棉纤维生产基本上无扭力单纱。

15 所述的技术和方法纯粹是机械的, 因此可以完全消除最终的单面针织物的转曲, 而不通过任何热的或湿的或化学的处理。对原纱和变形纱两者以及其最终织物的性能和特征的评估结果是, 在织物的表面性能、手感、透气性和导热性上都地非常好的。织物顶破强度和抗起球性以及纱线抗拉强度的下降有所缓解并在连续的处理或穿着中不会出现问题。

20 在忽略纤维间摩擦时, 总的纱线扭力可以用三种由单纤维作用的分力来表示, 即, 弯曲、扭转和拉伸分力。在来自第一步的环锭纱中, 单纤维的作用是相加的, 因为它们一般是在同一方向上。可是, 在单纱具有芯皮结构的情况下就不是这样了, 例如在第二步骤中的非常规系统中所纺的纱线情况下。在芯或皮中的纤维可以具有不同的纤维取向, 因此, 单纤维的作用可以抵消。合适的单纱可以退捻以达到零值的总纱线扭力或扭力平衡状态。

25 改性处理可以通过在第二步骤中给纱线提供预定退捻量的方式来完成。在上述捻线机上, 例如在环锭捻线机、倍捻捻线机或花式捻线机上, 以预定捻度量在其初始捻度的反方向上对原纱进行加捻, 在连续处理工艺中, 有一个机械装置安装在纺纱机上使纱线筒子旋转, 这样就可以在一台纺纱机上以连续的方式进行退捻操作。

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在图3中,所显示的是四种单纱沿其纱线半径的捻度分布,这四种纱线为:DREF-III纱、喷气纱、气流纱和环锭纱。前三种纱线呈现出某些不均匀的捻度分布,图4(a)中说明的是DREF-III纱的实例。环锭纱具有均匀的分布,因此不适用这种改性处理。

5 在图4(b)中显示了根据本发明生产的无扭力纱线。纱芯13在第一步骤中被施加了一个捻度,在改性过程中例如通过一台环锭或倍捻捻线机被减小。这样,纱线的外纛或芯皮14就具有一个剩余捻度,它是在第二步骤中由捻线机加捻形成的。加捻的相对量和在相反方向上的剩余扭力在纱芯13和外纛14之间基本上得以平衡。

10 因此,利用非常规纺的纱线的芯皮结构,所述纱线的改性方法可以用于多种纺纱或加捻系统纺制的单纱,例如,气流纺纱、摩擦纺纱和喷气纺纱系统。这种方法可以应用于任何纤维种类及混纺。例如,天然纤维或再生纤维,如纯棉、纯毛、粘胶人造丝或这些纤维的混纺。例如,可以用100%的棉纤维生产基本上无扭力单纱。

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25 单纱可以退捻以达到零值的总纱线扭力或扭力平衡状态。

改性处理可以通过在第二步骤中给纱线提供预定退捻量的方式来完成。在上述捻线机上,例如在环锭捻线机、倍捻捻线机或花式捻线机上,以预定捻度量在其初始捻度的反方向上对原纱进行加捻,在连续处理工艺中,有一个机械装置安装在纺纱机上使纱线筒子旋转,这样就可以在一台纺纱机上以连续的方式
30 式进行退捻操作。

可以理解, 为了生产无扭力纱线, 在第二步骤中所需要的加捻或纺纱量必须使得在第二步骤之后在纱线中保持零扭力或基本上零扭力。由于这种作法将纱线从一种类型变化成另一种, 因此, 在实际应用中, 在第二步骤中的反向加捻量最好是用实验方法确定。

5 例如, 可以借助一个加捻/退捻纱线的捻度试验对纱线样品进行退捻, 接着测量所处理纱线的捻度不稳定性。可以对每一纱线样品, 假定对四十种具有不同退捻水平的试样进行捻度不稳定性测试。随着加进的反向捻度的增加, 纱线的捻度不稳定性逐渐下降并当达到平衡结构时减小到零。为零的捻度不稳定性是用线性回归法确定的。

10 即使如此, 如果将在零一捻度不稳定点的退捻量作为加进单纱的反向捻数, 就可能需要某种纤维间摩擦、纤维、纱线和织物参数的调整。考虑的问题包括纤维类型、纱线和织物参数以及存放时间。另外, 还应该对气流纺纱机中的机械装置进行选择, 例如纺纱杯、阻捻头、止捻器, 以便通过增加纤维包覆以及改善纤维的径向分布来改进改性气流纱的性能, 以致单纱的剩余强度达到
15 继续加工的要求。预期的退捻水平应该是在三个 5A 洗涤周期之后使平针织物中的织物转曲角小于 3 度。

在纱线处理生产环境中, 一旦估定了实验数据, 设置好捻线机的操作参数, 则可以开始进行生产。可是, 如果需要, 然后可以对捻线机进行微调以达到生产出无扭力纱的目的。如果需要, 这种微调可以通过在任何大规模生产过程中
20 经常进行质量保证检测来实现。重要的是, 一旦确定或估定了初始调整, 就可以在实验数据的基础上容易地确定出可以获得所需无扭力纱线所要求的微调角度和方向。

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说明书附图

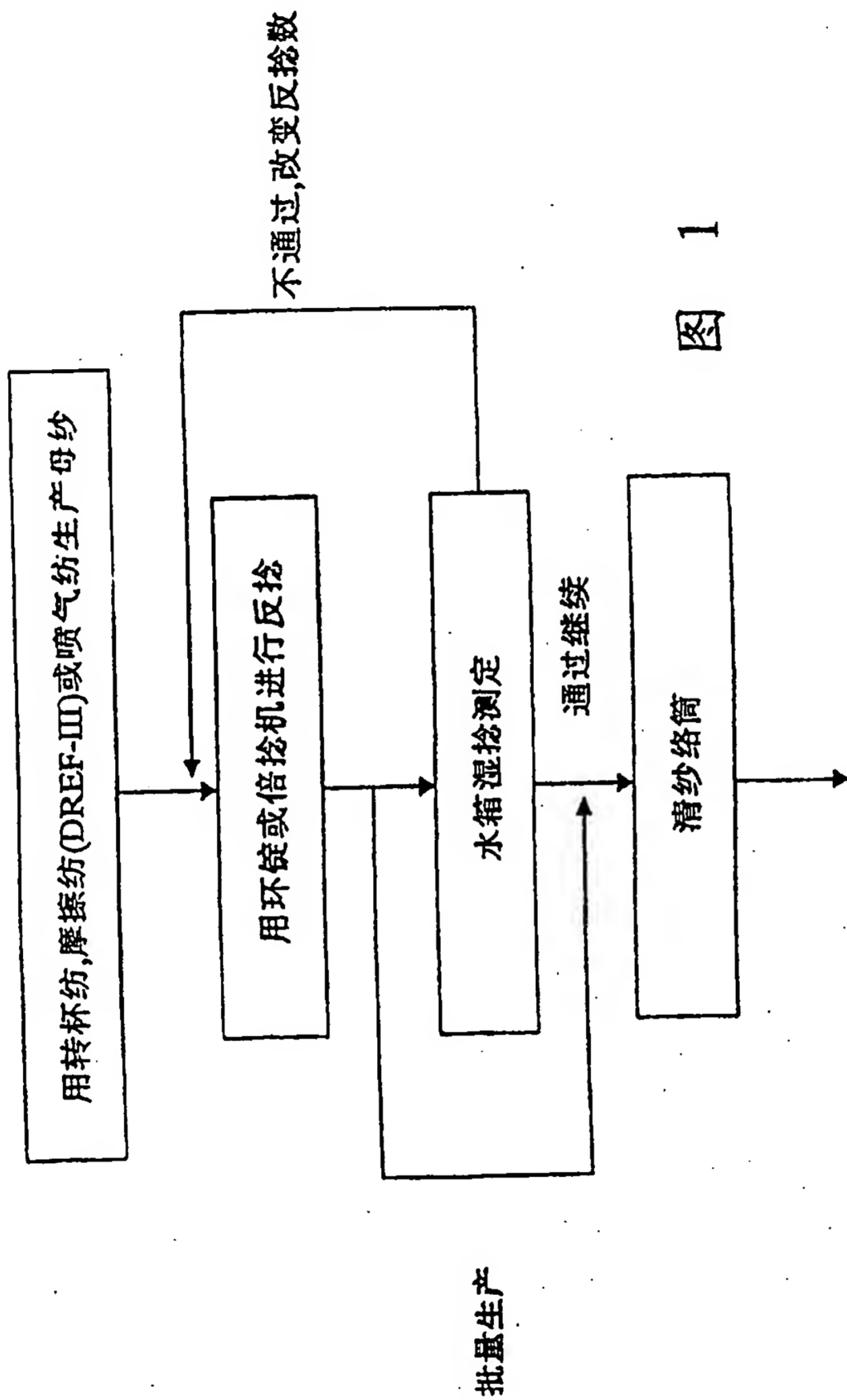


图 1

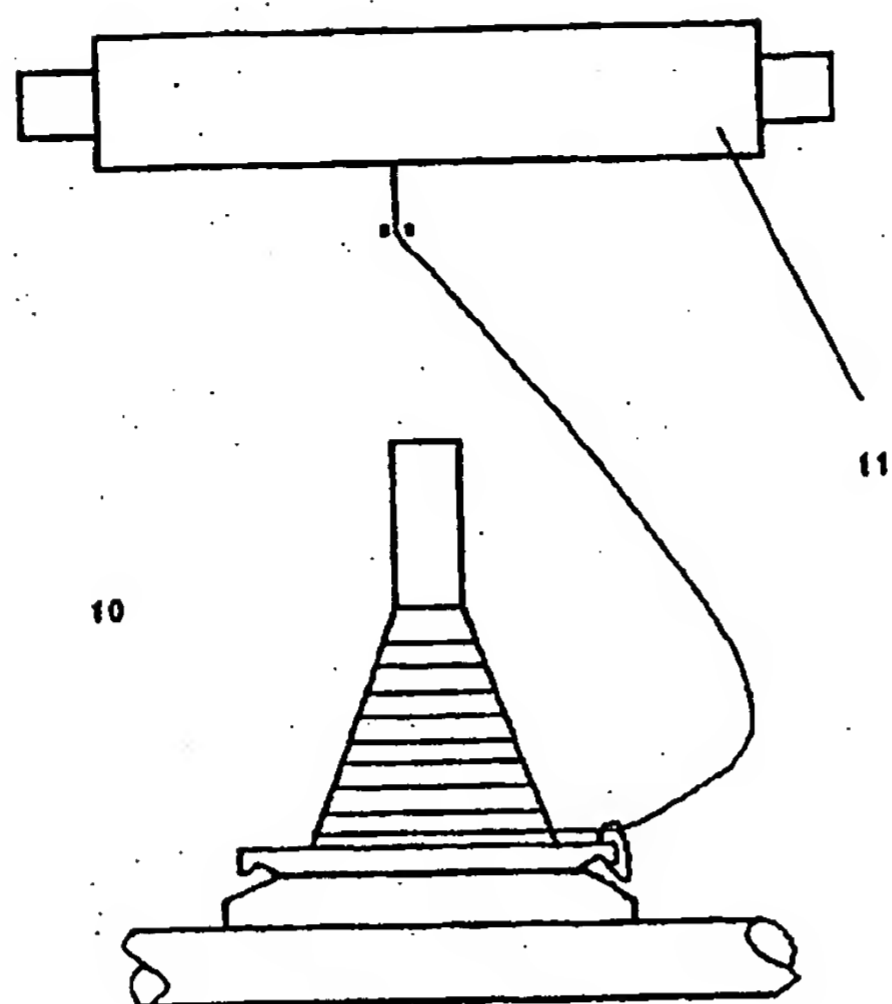


图 2(a)

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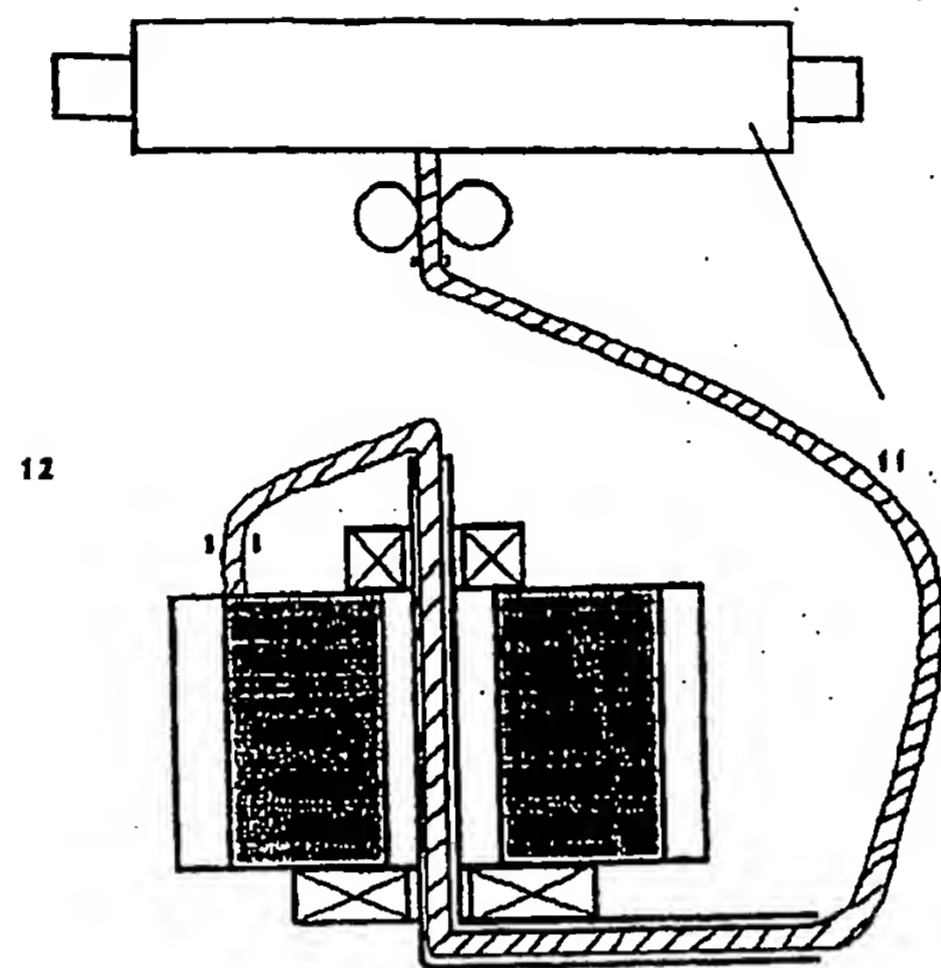


图 2(b)

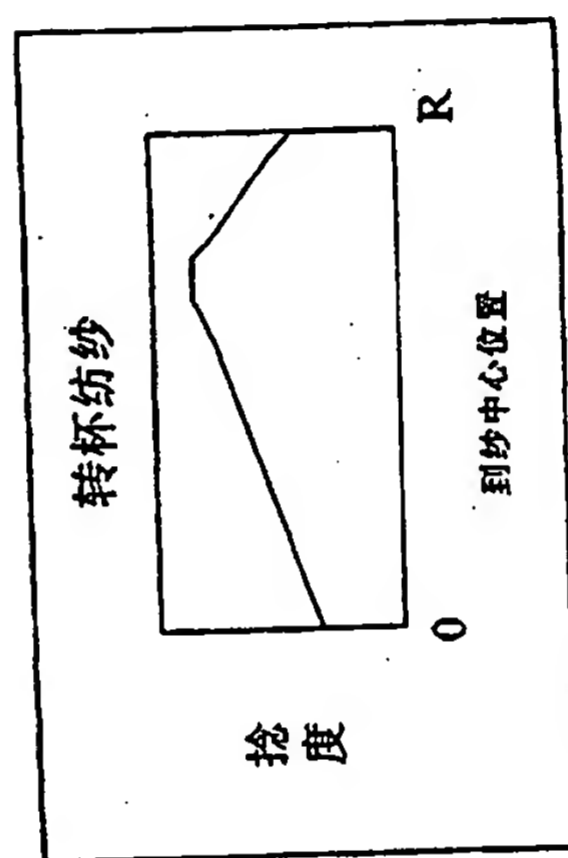
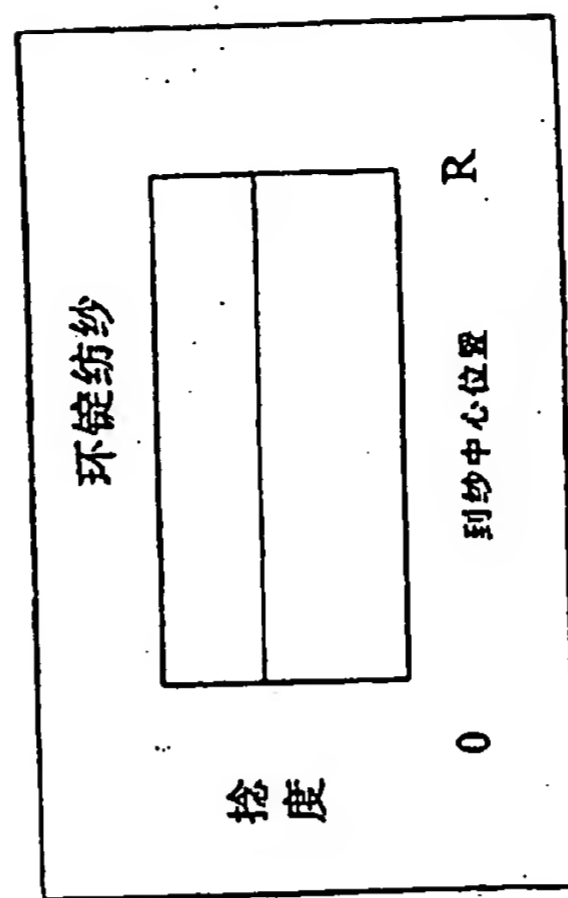
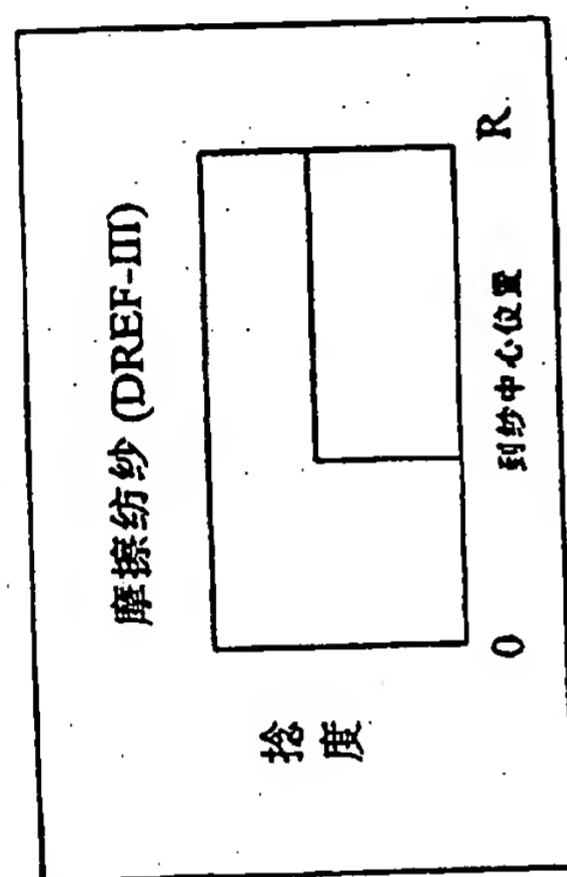
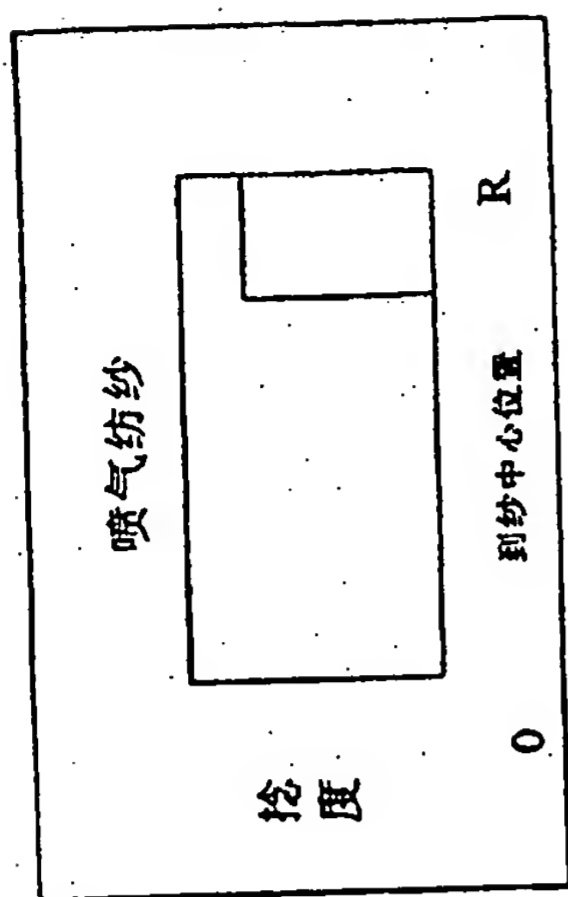


图 3

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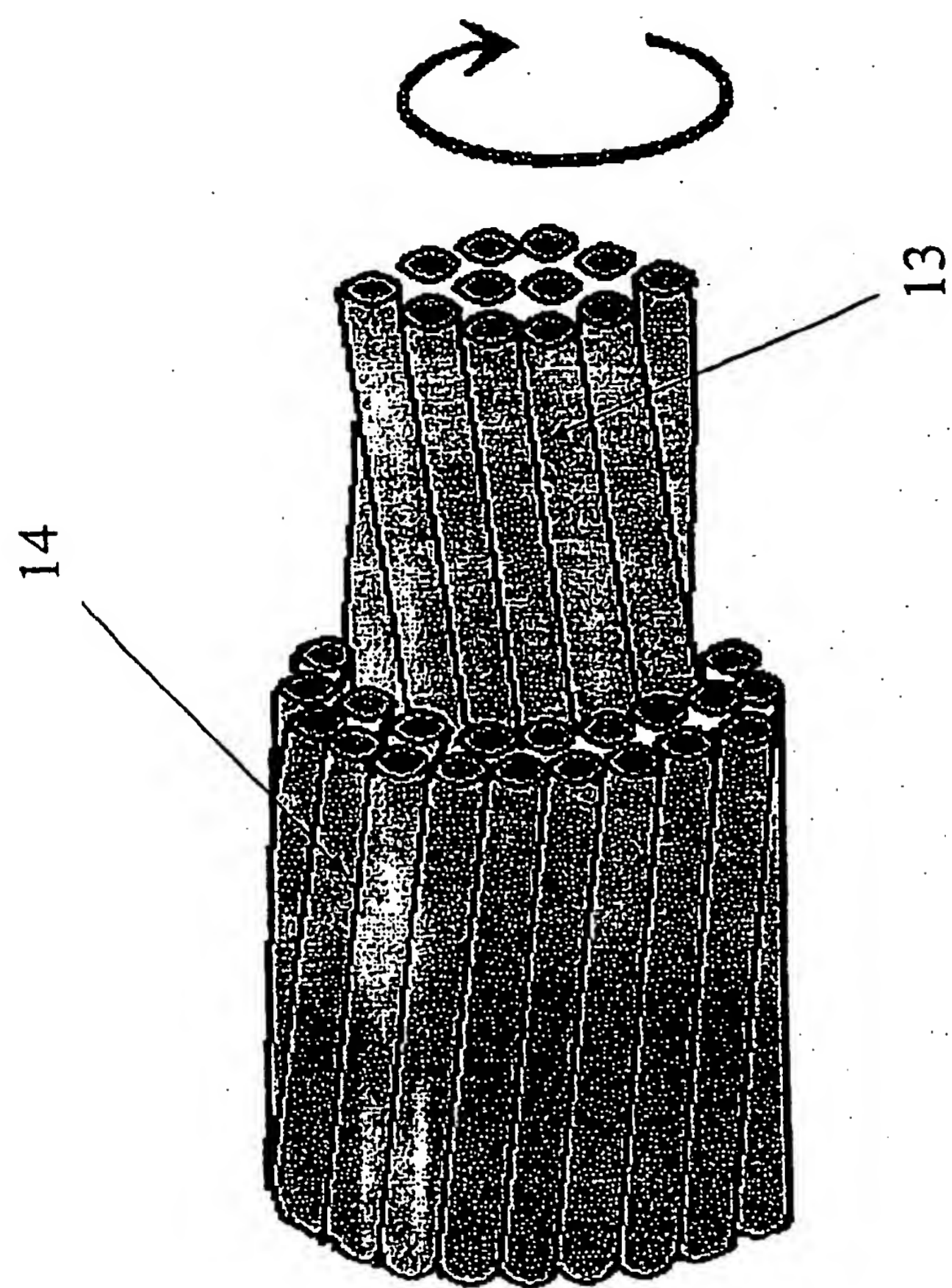


图 4(b)

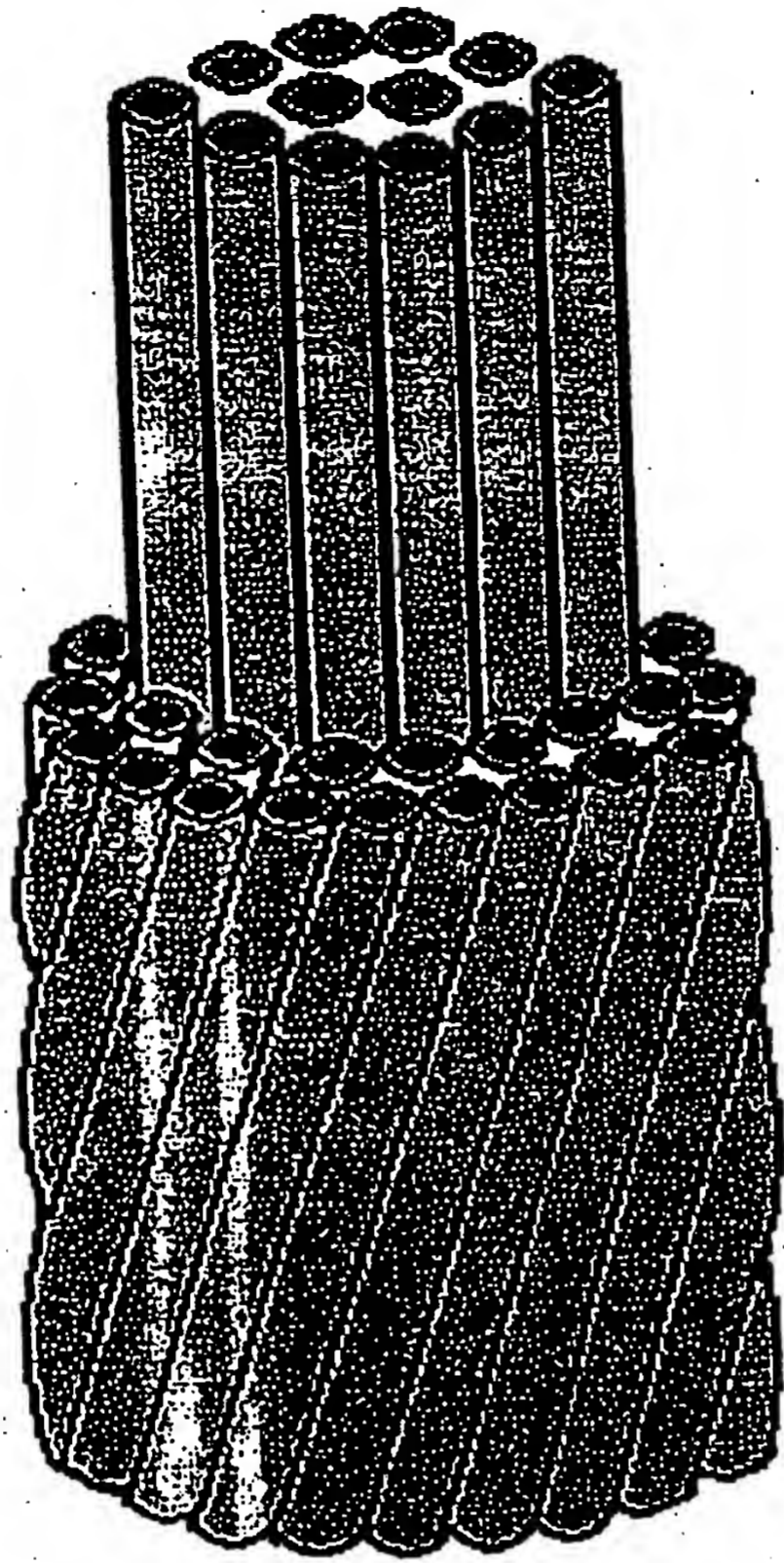


图 4(a)

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[12] Utility patent disclosure

[21] Application no. 00122254.6

[43] Disclosure date: January 9, 2002

[11] Disclosure No. CN 1330175A

<p>[22]App Date: 2000.6.17 [21] App No. 00122254.6 [71] Applicant: Hongkong Polytechnic University Address: Kowloon, Hong Kong [72]Inventors: Tao Xiaoming, Yang Guorong</p>	<p>[74] Patent agency: China Patent Agents (Hong Kong) Ltd. Agent: Wen Dapeng Claims, 1 pg; Explanation, 5 pgs, Figures, 6 pgs.</p>
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[54] Name of Invention: Non-torque single yarn

[57] Abstract

Non-torque fiber yarn is twisted in one direction in the first step, then twisted in the opposite direction in the next step. Production parameters are set to produce a short-staple single yarn. In this short-staple single yarn, the central core's residual torque is fundamentally balanced by the residual torque in the covering fibers.

[Translator's note: diagram illegible]

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Claims

1. A method for production of non-torque short staple single yarn, which includes a first step for production of non-torque short staple single yarn. Said short-staple single yarn has an uneven twist orientation distribution on its cross section, and a second step that uses mechanical force to impart a reverse twist on the yarn. This step is controlled in such a way that the residual torque in the central core of the yarn is essentially balanced by the residual torque in the fibers surrounding the core.

2. As in Claim (1) above, a method for production of non-torque short staple single yarn in which said method is a one consisting of two separate steps.

3. As in Claim (1) above, a method for production of non-torque short staple single yarn in which said method has two ordered steps carried out continuously, in which yarn goes through yarn production and twisting equipment in that order.

4. As in Claim (1) above, a method for production of non-torque short staple single yarn in which the second step in said method is accomplished using a ring twist machine.

5. As in Claim (1) above, a method for production of non-torque short staple single yarn in which the second step is accomplished using a two-for-one twister.

Disclosure

Non-torque single yarn

The present invention consists of a non-torque single yarn.

The art of twisting short staple yarn is already known. Short staple yarn is twisted primarily to give it structural integrity and to impart the necessary characteristics for its use in production of finished articles. Twisting has already been in use for several decades; however, it often leads to single yarn with obvious excess torque. To solve this problem, double strands are twisted together into single yarn to make finished articles, with the torque remaining in these strands oriented in opposing directions.

In the line of further general background, excess torque or unstable twist in twisted yarn is the most obvious and the most important factor leading to spirality in single knit fabrics. If such yarn, with an unstable twist, is used in knitted fabric, the loops so produced will not be symmetrical, owing to the variation in twist in the yarn. Such twisted yarn will have a tendency to untwist the internal twist to seek a natural structure of the least possible energy. This sort of yarn will tend to twist in fabric. In this way, one side of the loops will stick out of the surface while the other side of the loop will stay inside the fabric. This sort of twisting of the loop symmetry causes twisting and skews the grain and the pattern of the fabric it is used in.

In a knitted fabric, the spirality depends on the type of fiber used. This is to say that different types of fiber have different moduli (tensile modulus, flexural modulus and shear modulus) as well as different cross-sectional shapes. Consequently, different levels of stress will appear in the yarn. An increase in torque in the yarn raises instability of twist in yarn and, as a result, increases the twist in single knits produced with this yarn. Consequently, different fibers and different tensile moduli will affect the processing of yarn or fabric afterwards, due to the twisting of the yarn from the degree of yarn stretch. It can be said that in a cotton/polyester blend yarn, increasing the percentage of polyester will increase twist instability in ring spun or open-end yarn, and in turn increase twist and warpage in single knit fabrics made with these yarns. Since in the same yardage of cotton/polyester blend, the blend with the higher polyester content will show more twist, it is quite possible that this is because of the higher modulus and that these two fiber types will show cross-sectional differences.

Additional twisting when yarns are knit subjects yarns to a longitudinal force that uses friction to unite the fibers. However, in reality, in different yarn structures, internal

stress distribution varies. Experimental results have shown that DREF-II yarn has the highest twist liveliness or torque, and yarns spun using ring spinning, open-end (ring spinning) or air-jet methods have smaller torque. Moreover, among knit fabrics, fabrics made from friction-spun yarns have the largest twist angle.

Differences in residual torque among these four types of yarn reflect the differences in structure between them. Ring-spun yarn is often regarded as having an evenly coaxial spiral structure of even density in its cross section, and turning of the fibers is therefore a characteristic of secondary importance. Thus, when yarn unwinds back to the original degree of twist, its strength is reduced to zero and the yarn will fail as a result. On the other hand, yarn with uneven twist distribution produced by a non-standard yarn system includes open-end yarn, air-jet yarn and/or DREF-II yarn. Moreover, these yarns do not have an even density, and localized fiber tangles and fascia are a common characteristic of all. When unwound, the strength of these yarns does not go to zero.

Accordingly, several factors currently seriously impact the residual torque of yarns, including fiber type, fiber cross-sectional shape, spinning system and structural geometry of the yarn. Additionally, there are several other factors that influence the residual torque of yarns and/or impact relative freedom of internal loop movement in knits, impacting the final deformation of fabric. These factors include knit pattern, knitting machine setup, and retraction and shaping due to postproduction.

In the past, various techniques have been developed to reduce or eliminate residual torque in spun yarns. Based on one basic principle, these techniques can be divided into two major groups. The first group is permanent shaping of the yarn; the second group features physical shaping to balance residual torque.

As is well known, the more permanent shaping that is done to a fiber, the less the warpage caused by residual torque in the yarn. Based on the type of fiber, various methods can be used to shape yarns. For heat-set fibers, heat processing is done as yarn or fabric is under tension. Temperature is above the glass transition temperature but below the boiling point (as in false twisting). Heat setting of cotton/polyester blend single yarns greatly decreases residual torque, and was even capable of nearly eliminating twist in air-jet and rotor spun yarn in fabric.

In the case of natural fibers such as cotton or wool, setting is more complex. Examples include steam setting or setting in hot water and chemical treatment, or mercerization for cotton and the use of sodium bisulfate for processing of wool. However, setting of natural fibers cannot completely eliminate residual torque in a single ply, and may cause damage to fibers and worsening of yarn characteristics.

Some torsion balancing techniques in industrial use include: (1) plying with two strands with an equivalent but directionally opposite twist; (2) inserting two strands with equivalent but directionally opposite twist in the same thread guide; or, most simply, (3) use of two strands with the same but directionally opposite twist for knitting using the plating technique.

Moreover, some have suggested a number of direct spinning methods to produce zero-twist single yarn. A dual link spinning has been proposed to produce balanced torsion yarn. Yarn made using this system has a core produced through jet spinning, after which it is wrapped with DREF-III and covering fibers. At the end of the process, the yarn core and wrap layers have twist/torque in opposite directions. Another technique is used to produce yarn with a ring spun outer layer and a polyester core. Here, a core yarn twisted in the opposite direction to the covering layer, or a simple heat texturing of the polyester is used to equalize the twist.

Compared to setting, balance methods have clear advantages, particularly in the case of natural fibers. First, balancing is a physical treatment that involves no chemicals. Therefore, damage to the fiber can be avoided. Second, balancing can be used on all types of fibers, including natural fibers. However, when a plied yarn's finest count is half the finest count of a single yarn, if two plies of single yarn are used to form a balanced structure, currently in the industry the most commonly used method of taking two strands limits the minimum weight of fabric. If direct spinning is used to create a balanced twist single yarn, a number of economic concerns are involved, because certain modifications must be made to the machinery.

The goal of the present invention is to overcome or at least reduce these shortcomings.

Based on this invention, we will provide a means of manufacturing torque-free short staple yarn. Following is an explanation of this invention with reference to the accompanying diagrams and embodiments. To wit:

Figure 1 is a flowchart showing the production steps for lot production of this type of yarn;

Figures 2(a) and 2(b) show the equipment used to produce this type of yarn;

Figure 3 shows distribution of twist in different yarns; and

Figures 4(a) and 4(b) explains the principles of yarn processing.

With reference to the attached figures, Figure 1 shows two methods for lot processing. The first method includes processing of the raw yarn. These basic yarns are produced using any of the following methods: open end spinning, air jet spinning and DREF-III. They are modified using a ring or two-for-one twister. The modified yarn thus

obtained will be wet-wrap tested. If testing shows that residual torque is within acceptable limits, the yarn satisfies the requirements of being zero-torque, and can be spooled. Otherwise, the modification process must be adjusted until the yarn passes. The second method is used in batch production. A ring spinner or two-for-one spinner is used to modify the raw yarn, after which it is unwrapped and spooled.

As per figure 2(a), yarn modification is accomplished using a ring spinner. A supply roller 10 supplies yarn to a take-up roll 11. Further, a two-for-one twister may also be used, as shown in figure 2(b). The spool of raw yarn is placed on ring 12 on a revolving winding axle. Each time the ring revolves one turn, the yarn receives two turns. The yarn is spooled onto take-up roll 11.

In figure 3, twist distributions are shown for four types of single yarn based on the yarn diameter. These four types of yarn are: DREF-III yarn, air-jet yarn, open-end yarn and ring-spun yarn. The first three yarn types display unevenness in twist distribution, and figure 4(a) gives an explanation for DREF-III. The ring-spun yarn has an even distribution and so is unsuitable for this type of processing.

Figure 4(b) shows non-torque yarn from this invention. Yarn core 13 is given a twist in a single step. During the modification process, for example, using a ring twister or two-for-one twister, the twist is reduced. In this manner, the outer wrap 14 has excess torque. This is formed in step 2 using a twisting machine. An equal and opposite reverse excess torque basically balances the core 13 and outer wrap 14.

As a result, when using a non-standard core structure, the yarn modification method described may be used on many types of single yarns produced by forming or twisting systems, for example, open-end yarn, friction-spun yarn and air-jet yarn systems. This method can be utilized on any type of fiber or blend. For example, it can be used on natural or recycled fibers, such as pure cotton, wool, viscose rayon or blended fibers. For example, it can be used on 100% cotton fibers to produce an essentially zero-torque yarn.

The technique and method described are purely mechanical in nature, so warpage in the final fabric can be completely eliminated. No heat, moisture or chemicals are used in processing. Results on the characteristics of the raw yarn, spun yarn and fabric produced therefrom show that the surface characteristics, feel, comfort and thermal conductivity are all excellent. Reductions in bursting strength, pilling resistance and yarn tensile strength were reduced and no problems were noted under continuous processing and wear.

If friction between fibers is ignored, total torque can be represented using three components of force on the three types of fibers. These are flex, torsion and tensile force. In ring-spun yarn from step 1, the function of single fibers is relatively greater, because

they are generally running in the same direction. However, when single yarn has a core structure, this is not the case. An example is yarn from non-standard systems in step 2. The fibers of the core and cover layers can have different fiber orientations, and as a result, the effect of a single fiber can be offset. Suitable single yarns can be untwisted to reach an overall zero twist balance in the yarn.

Modification processing can be done through step 2 to give the yarn a predetermined twist. This can be done using the twisting machines listed above, such as a ring twister, two-for-one twisting machine or pattern twister. These machines are used to impart a predetermined twist in the opposite direction to the original twist, and under continuous processing, an apparatus is installed on the spinning machine to spool the yarn. In this way, one spinning machine can be continuously operated for twisting.

As can be understood, in order to produce zero-torque yarn, the added twist or spin amount required in step 2 must make the yarn zero torque at the end of that step. Since this method changes yarn from one type to another, in actual practice the amount of twist in the opposite direction during step 2 is optimally determined using experimental methods.

For example, a twist-untwist yarn test can be used on yarn samples to determine the amount of instability in the twist. An instability test can be done on each yarn sample, assuming that there are 40 types with different levels of twist. With greater reverse twist, the twist instability in the yarn gradually declines and when it reaches a balanced structure, it declines to zero. A zero value for twist instability can be established through the use of linear regression.

Even in this case, if the amount of reverse twist required for zero instability will be used for reverse twisting of single yarn, adjustments may be required for friction between fibers and fiber, yarn and fabric parameters. Issues to be considered include fiber type, yarn and fabric parameters and storage time. Moreover, a choice must be made as to the apparatus to be installed on the open-end spinning machine, for example, a spinning ring, anti-twist head or twist stopper to facilitate increasing the fiber covering and improving the fiber orientation distribution to improve and modify the characteristics of open-end yarn so that the residual torque in single yarn satisfies the demands of continuous processing. The calculated level of unwind should be such that the fabric torque angle for flat knit fabric after three 5a detergent cycles is less than 3 degrees.

In a yarn production and processing environment, as soon as the experimental data is established and operating parameters put in place for twisting machines, production can begin. However, if required, small adjustments can be made to the twisting machines later to achieve zero-torque yarn. Likewise, if required, this type of small adjustment can

be done based on any quality assurance measure done on a large-scale production process. The main point is that the minute the initial adjustments are made, the experimental data can be used as a basis to easily establish which small adjustments are required to angle and direction in order to produce zero-torque yarn.

Explanation of the figures

Uses ring-spun, friction-spun (DREF-III) or air jet spun raw yarn

Reverse twisted with ring or two-for-one twister
settings

No pass Change reverse twist

Batch production

Wet chamber moist twist tests

Pass and continue

yarn-clearing spool

FIGURE 1

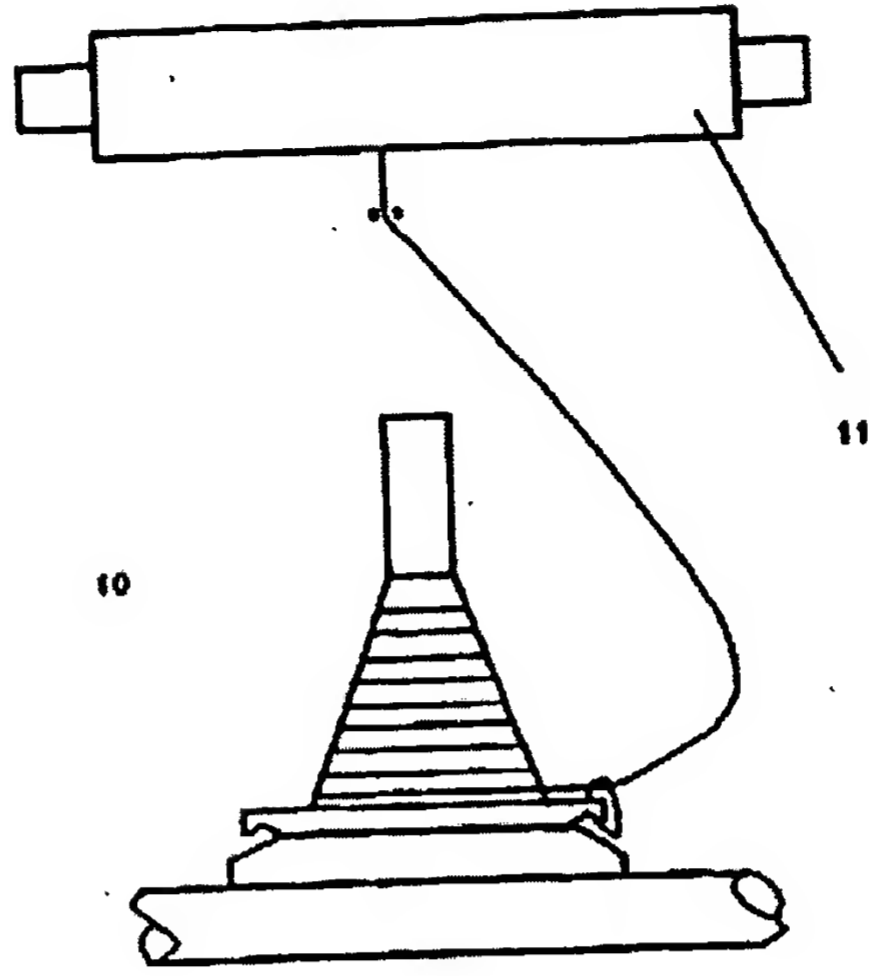


Figure 2(a)

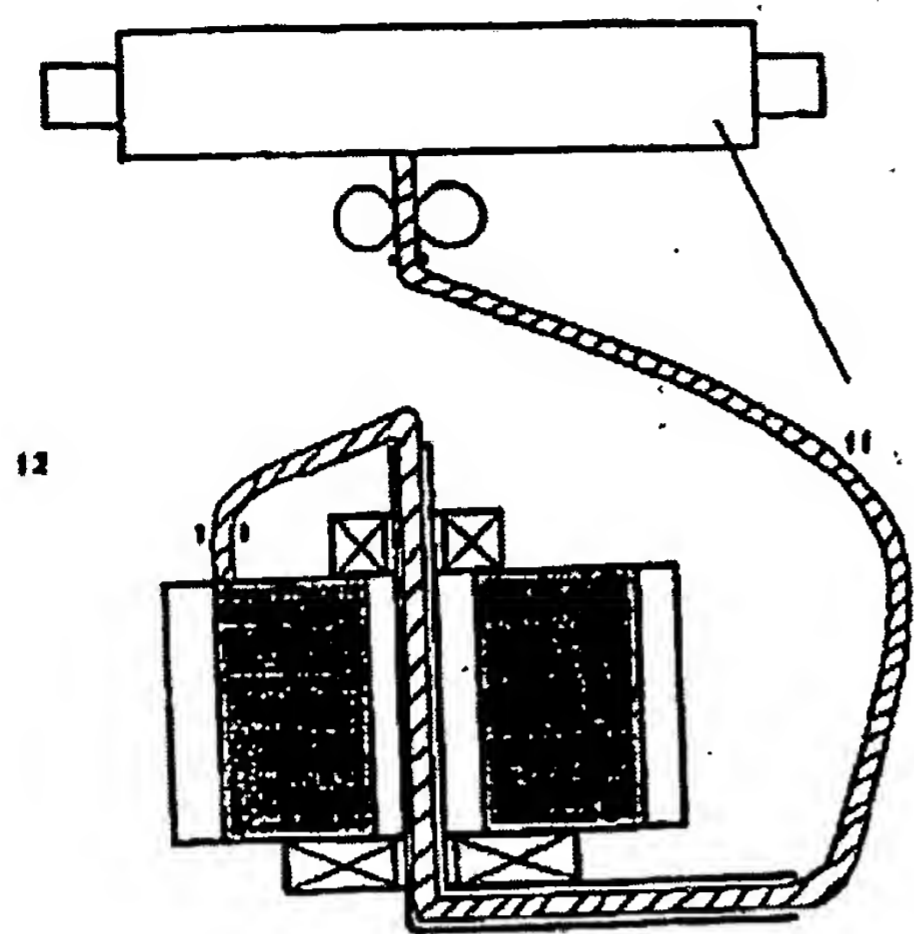


Figure 2(b)

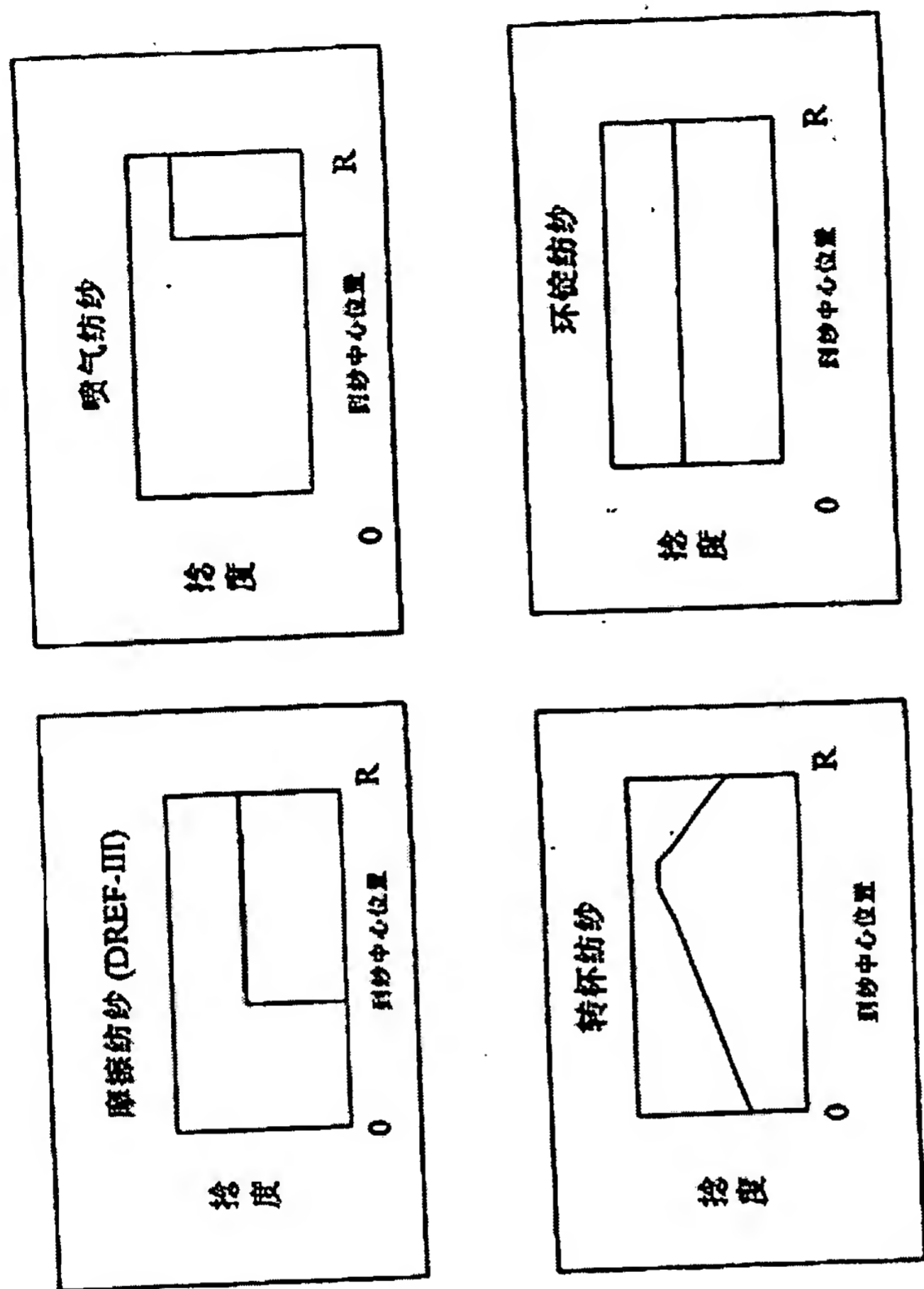


Figure 3

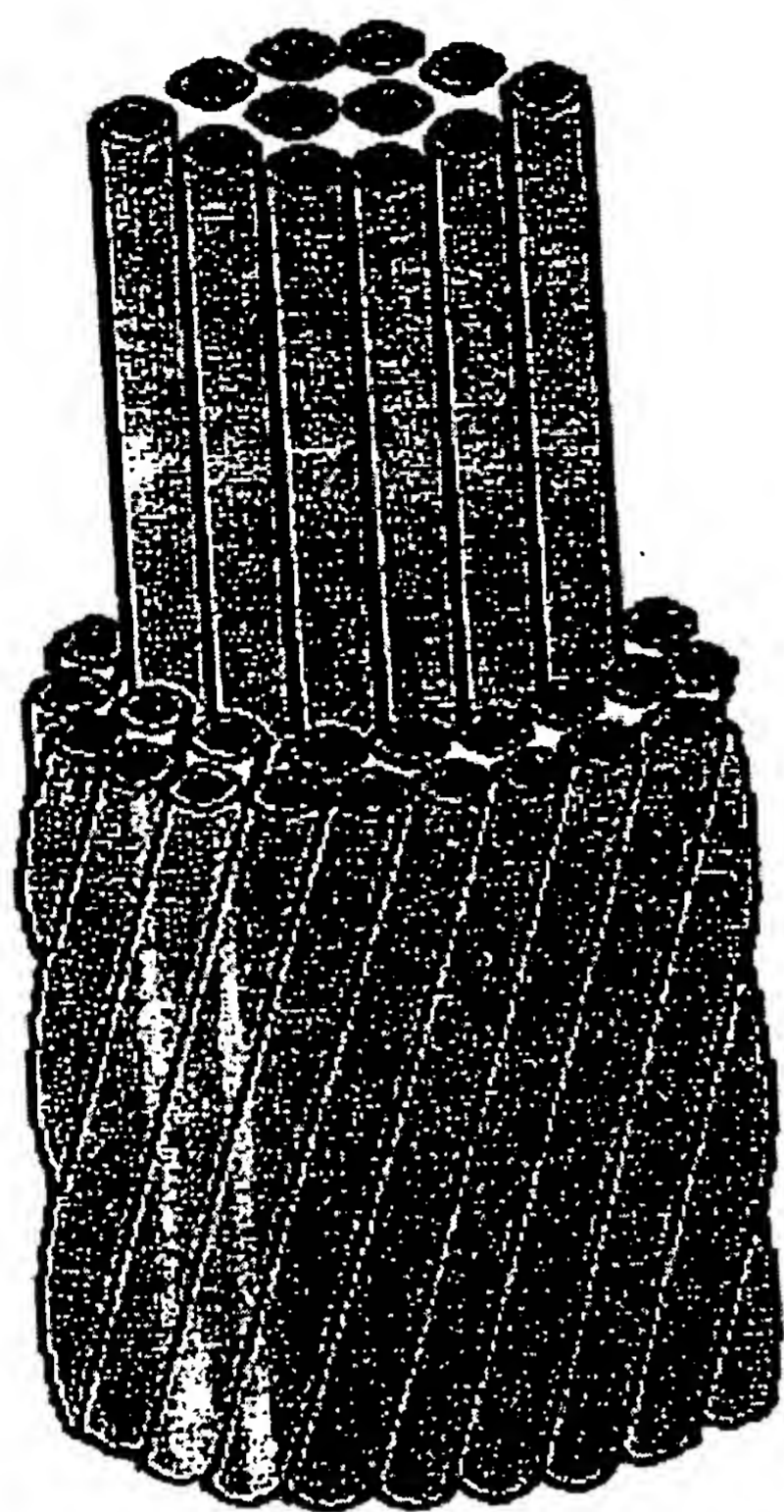


Figure 4(a)

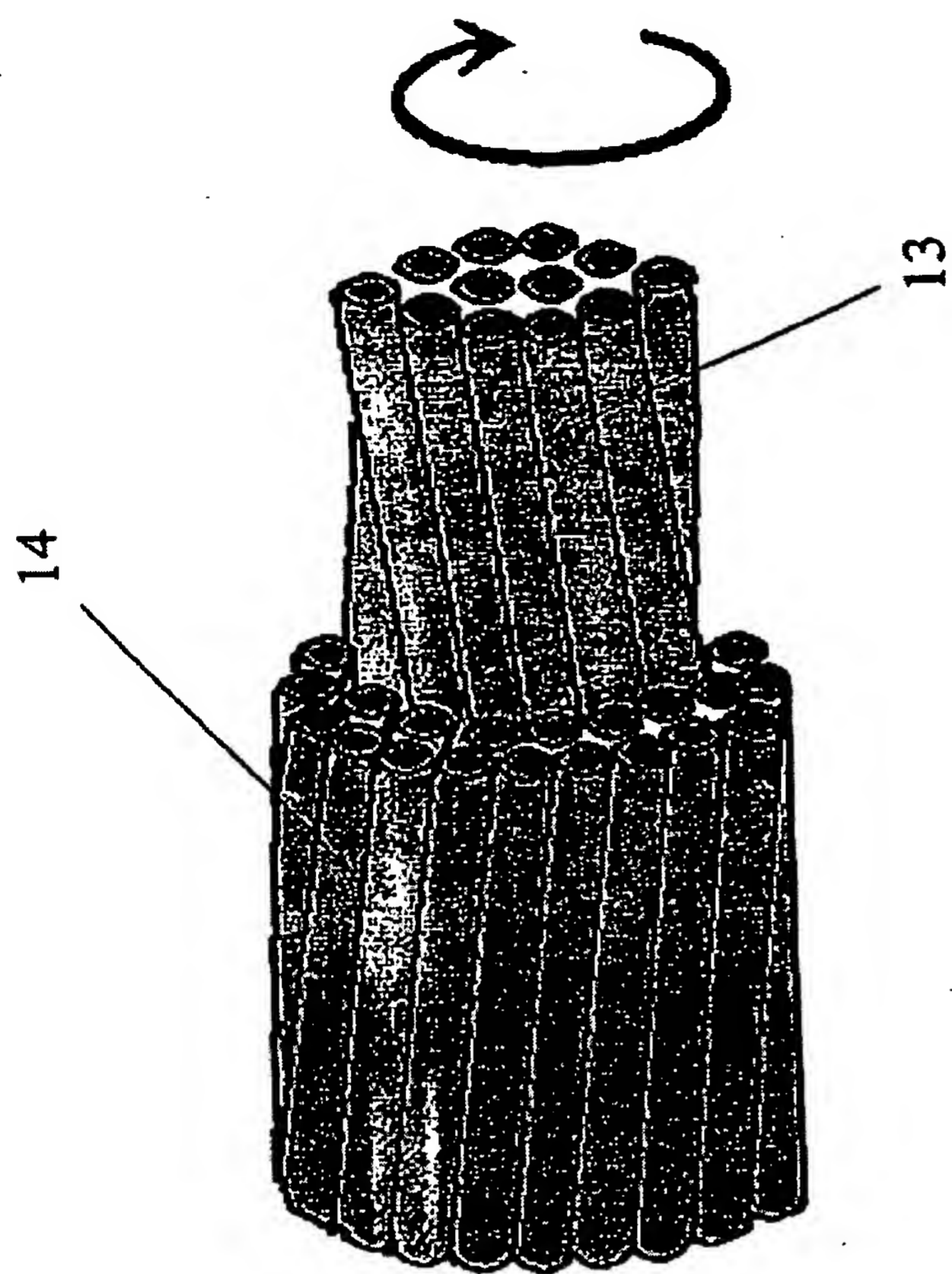


Figure 4(b)

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